



A Sensor Web Responds, and a NASA Technology is Tested, After Crash of US Airways Flight 1549 in the Hudson River

In the moments after US Airways Flight 1549 crash-landed in the Hudson River on January 15, 2009, the New York / New Jersey Office of Emergency Management sprang into action to deploy rescue boats near the crash site. Water conditions – currents, current direction, and temperature – can have a big impact on water rescue operations, but in those first moments few people had solid information about conditions on the river. Even fewer people could reliably predict how conditions were likely to change in the ensuing minutes or hours.

Enter Dr. Alan Blumberg, a professor of Ocean Engineering at the Stevens Institute of Technology in New Jersey. Dr. Blumberg is responsible for an extensive array of sensors – a sensor web on land and in the water – along the New York / New Jersey coastline called the New York Harbor Observing and Prediction System (NYHOPS). These sensors provide a broad range of useful measurements, such as water temperature, salinity, oxygen levels and currents as well as air pressure, temperature, and humidity. The NYHOPS sensor web even includes unmanned underwater vehicles that can be deployed for additional measurements when needed.

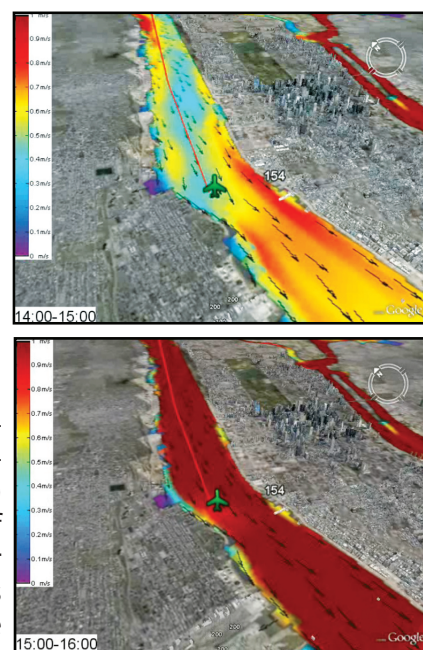
The data from NYHOPS is regularly run into an ocean model to create 48-hour forecasts around various parameters – water levels, current magnitude and direction, salinity, temperature – for the entire region as well as produce maps of water conditions. These maps and forecasts are used for many purposes: harbor authorities and ship captains check on currents and water levels, scientists monitor oxygen levels and watch for algae blooms, and health and energy management services monitor water quality, pollution, and storm surges, to name a few. The Office of Naval Research, NOAA, the Department of Homeland Security, and the New Jersey Department of Transportation all have keen interests in NYHOPS and help fund its operation and continued development.

NASA also became involved with NYHOPS to develop, test and implement state-of-the-art sensor web technologies. A NASA technology project, run by Dr. Ashit Talukder at the Jet Propulsion Laboratory and funded by the NASA Earth Science Technology Office, has

made significant contributions to the system, including a 3D visualization toolkit for coastal and maritime predictions using GoogleEarth™ software. The new 3D toolkit allows users to seamlessly pan-tilt-zoom and navigate the entire region as the hourly maritime river and coastal predictions are viewed on GoogleEarth. Multiple water and coastal parameters can be observed simultaneously from any viewing angle, and other geographical or geospatial information (like 3D building geometries) can be overlaid for a variety of new applications. Users could, for example, view water conditions and the New York skyline from the point of view of a ship for better navigation. The 3D toolkit will soon be available online to the public for New York Harbor area maritime weather predictions.

Dr. Talukder also led the development of autonomous operation upgrades for the NYHOPS sensor web that include predictive control, artificial intelligence and machine learning. When fully implemented, the system will enable the sensors within the network to react to detected or predicted events, communicate more efficiently, adjust data sampling rates, and conserve power, all without human intervention. The system can also automatically deploy the NYHOPS unmanned underwater robotic vehicles in response to ongoing and predicted events: storm surges, plumes, algal blooms, oil spills or even security threats.

Continued on Reverse



Above: Two clips from a movie of 3-D visualizations of water current magnitude and direction on the Hudson River from January 15th. The top image shows conditions from 2-3pm and the bottom clip from 3-4 pm. The crash site of the plane is shown as an plane icon. Visit the ESTO website at: esto.nasa.gov to view this visualization.

When he heard about the crash landing, Blumberg immediately went to work preparing a summary of present and forecasted water conditions along the NY/NJ rivers and coast. "Within 30 minutes of the crash, I was in touch with the Office of Emergency Management (OEM) Watch Command Supervisor via telephone regarding the water conditions", said Blumberg. "My suggestions were to deploy rescue assets downstream, not upstream, along Manhattan and to guide the plane eastward to the Battery area for salvage operations. Since the Battery has the weakest currents in this very energetic current environment, it was the easiest area to try and salvage the plane."

Some of the text from the forecast Dr. Blumberg generated that day reads as follows: *"Forecast valid at 1600 EST 01/15/2009: The temperature of the water is very cold, between 32 degrees at the surface, to 38 degrees at the bottom waters. Winds are northerlies, directed downstream on the Hudson at about 7 knots, steady for the next couple of hours. Water level is dropping and will drop another foot in the next two hours. Surface currents are to the south, increasing to a maximum of 4 knots (very fast) in the next two hours. No significant waves now or within the next two hours."*

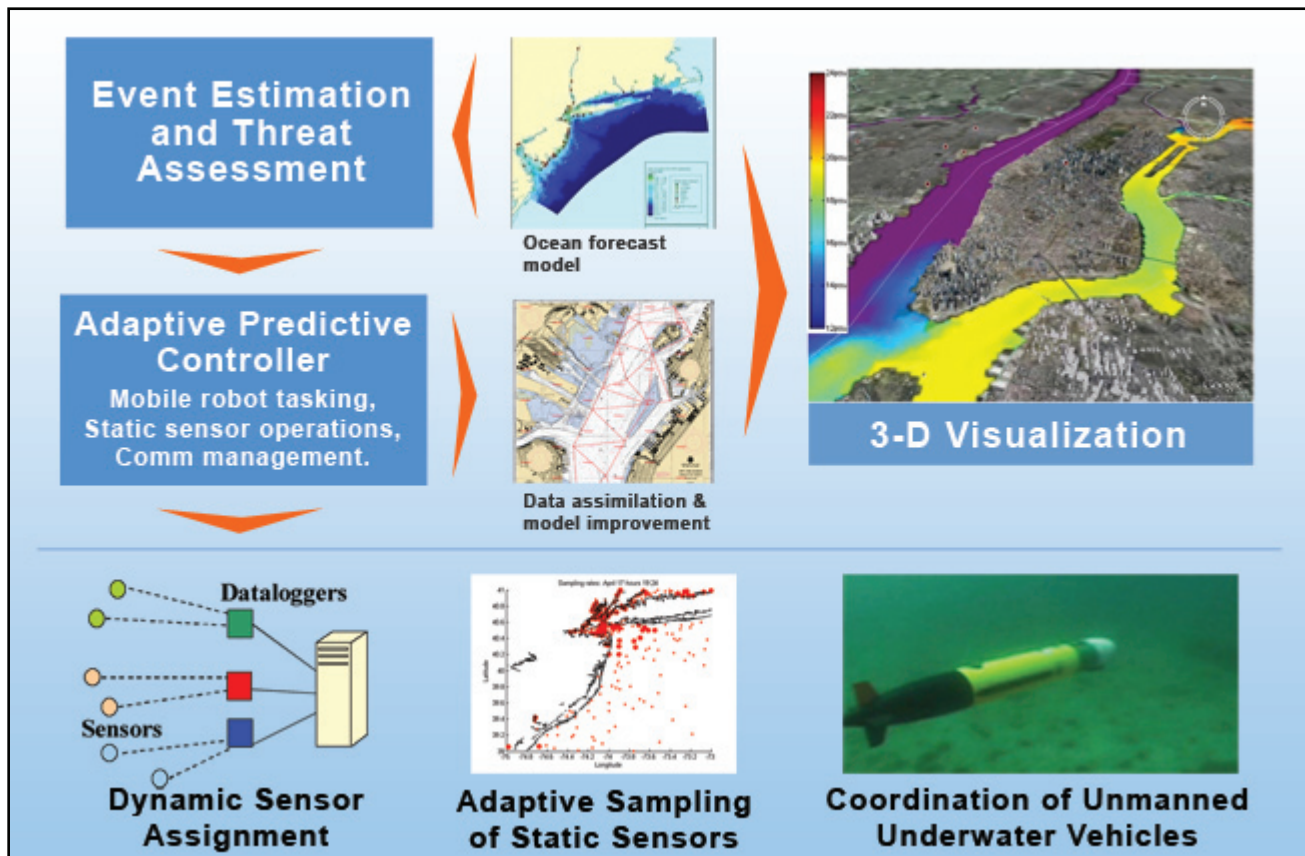
The NASA 3D visualization tool had not yet been comprehensively tested at the time of the crash so Blumberg relied on existing 2D capabilities for the initial response. After rerunning the data using the NASA tool, however, he found the technology to be reliable, robust, and "very useful compared to the existing 2D-image-based visualization tools." The 3D tool will be the de-facto choice for real-time response now that it has been tested. "We are very happy with the results and performance of our 3D sensor web visualization tool in a live-emergency situation ... which, thankfully, ended well," said Dr. Talukder. "We are even more confident now that further successes and uses will come out of this operational sensor web system as it evolves and improves."

In the days that followed, Blumberg and the Stevens Institute provided around the clock assistance to various emergency agencies, including the National Transportation Safety Board for the recovery of the aircraft and the left engine, which broke away during the water landing.

For more information about NYHOPS, visit the NYHOPS Website at: <http://hudson.dl.stevens-tech.edu/maritimeforecast/>

For more information about the NASA Jet Propulsion Laboratory Adaptive control and resource management technology, visit: <http://eis.jpl.nasa.gov/~atalukde/>

For more information on emerging technologies for Earth science, visit the ESTO website at: <http://esto.nasa.gov>



Above: A Summary of the Visualization, Control, and Resource Management Solutions Developed by a NASA Earth Science Technology Project at JPL for the NYHOPS Sensor Web.